A Measurement System Using Dual-phase Lock-in Amplifier for Optically Modulated Scattering Microwave Fields

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Microwave fields are generally measured with an open-ended rectangular waveguide type of probe or coaxial type of probe. The accuracies of the conventional measurement method are affected by a feeding cable and near-by conducting objects. Conventional probes may produce too much distortion of the field to be measured because a probe must be connected to the receiver by a transmission line or a cable. Thus, such a parasitic factor degrades the accuracy of the measurement significantly. In order to minimize the perturbation of microwave fields and improve the accuracies, the modulated scattering technique has been popularly used for measuring microwave fields. The modulated scattering microwave fields can be discriminated from unmodulated parasitic signals. The modulated component includes the amplitude and phase information that characterized microwave fields at the probe's location.

The conventional system for measurements of the modulated scattering microwave fields have an unstable measurement ability and a measurement limitation in terms of a frequency range because a homodyne receiver utilized a coupler to make quadrature phase component. An important factors, which limits the used of in-phase and quadrature coupler in wide band performance, are relatively narrow bandwidth and inaccuracy due to imperfect characteristics of a quadrature coupler in the entire operating frequency range. To overcome such a drawback, we propose the improved system. The directional coupler and quadrature coupler which limit the operating frequency range are eliminated from the proposed system. Instead of this, the detecting part uses a dual-phase lock-in amplifier. The signal frequency of $f_1 - 2f_m$ is used to demodulate the received signal instead of the coupled signal component of f_1. The dual-phase lock-in amplifier makes in-phase and quadrature phase components of only one component whose frequency is f_m. Therefore, the proposed system has more accurate and broadband than one with a conventional system.

To validate the accuracy of the measurement system, the measured amplitude and phase distributions of the double-ridged horn antenna in far field region are compared with those of the conventional system in the commercial band (0.8∼6.0 GHz).

The measurement system in a bi-static configuration is composed of Tx and Rx antennas, a modulated dipole scatterer, controller, and detecting parts. Double-ridged horn antennas (0.8∼6.0 GHz) are used for Tx and Rx parts. A 7 kHz modulated laser signal feeds a photodiode to modulate the received fields at the center of a dipole scatterer by optical fiber. The motion controller automatically adjusts the distance between Tx antenna and a modulated dipole scatterer, which has the fixed distance with Rx antenna. The detecting part consists of mixer and dual-phase lock-in amplifier using the modulating low frequency signal as a phase reference.